INVESTIGATON OF SELENIUM BIOTRANSFORMATIONS IN AQUATIC ECOSYSTEMS

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1. Introduction

Oxidized selenium compounds occur naturally in the western hills of the Central Valley of California. During irrigation these water-soluble compounds are mobilized and enter the aquatic ecosystems of the Central Valley. The toxicity of the Se to wildlife is highly dependent on the chemical form or speciation of the Se. Selenium can be assimilated into sediment through several pathways. The objective of this research is to investigate the cycling of Se from the oxidized form to the elemental and organic forms found in the sediments to gain an understanding of how different paths to reduction may cause differences in the post-reduction behavior of Se. It has been observed that microalgae play a key role in the Se cycle (Fan et. al, 1997). This research focuses on the assimilation of Se by microalgae, and the subsequent degradation of the algae by bacteria in agricultural drain water. The rate of reduction and oxidation of Se are compared to other pathways, such as direct non-biotic chemical reduction and direct reduction by bacteria.

2. Materials and Methods

Batch experiments were conducted using bacteria and algae cultured from water from the San Luis Drain. The concentration and the chemical speciation of Se were determined as the Se was introduced and assimilated into the algae, and as bacteria decomposed the algae in both oxidizing and reducing conditions. Analysis of Se speciation in algae, bacteria, and in water was done by x-ray spectroscopy at the Stanford Synchrotron Radiation Laboratory.

3. Results and Discussion

It was shown that selenite (Se^{+4}) is quickly incorporated into the microalgae without chemical transformation. The algae showed significant bioconcentration of selenite but did not concentrate selenate (Se^{+6}). As shown in Figure 2, the presence of selenate in the water did affect the ability of the algae to uptake selenite which may be due to the high ionic strength of the water-(Williams et al, 1994). Under anaerobic conditions, bacteria were able to reduce selenite in the algae, but this process took up to two months. In contrast, bacteria were able to reduce selenite in the water on the order of days. The analysis of the X-ray edge structure and position showed differences between the reduced forms of Se from the different pathways. (Figure 2). These results show that the Se pathway through the algae affects both the rate and the chemical form of Se.

4. Conclusions

The presence of algae in the shallow drainage basins may affect the chemical form and the rates of transformations of selenium. Incorporation of selenite into algae increases the time for bacterial reduction. The x-ray edge suggests also that the chemical form of the reduced Se may be different**,** which will affect both the re-oxidation rate and the bioavailability of the Se.

5. References

Fan, T. W-M., A.N. Lane, and R. M. Higashi. 1997. Selenium Biotransformations by a Euryhaline Microalga Isolated from a Saline Evaporation Pond. *Environmental Science and Technology*. **31**: 569-576.

Williams, M.J., R.S. Ogle, A.W. Knight,. and R.G. Burau. 1994. Effects of Sulfate on Selenate Uptake and Toxicity in the Green Alga *Selenastrum capricornutum*. *Arch. Environ. Contam.* Toxicol. **27**: 449-453.

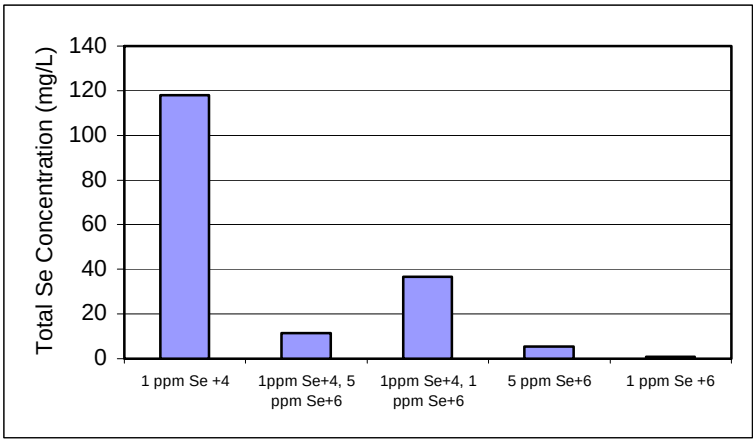

Figure 1: Selenite and selenate uptake by algae.

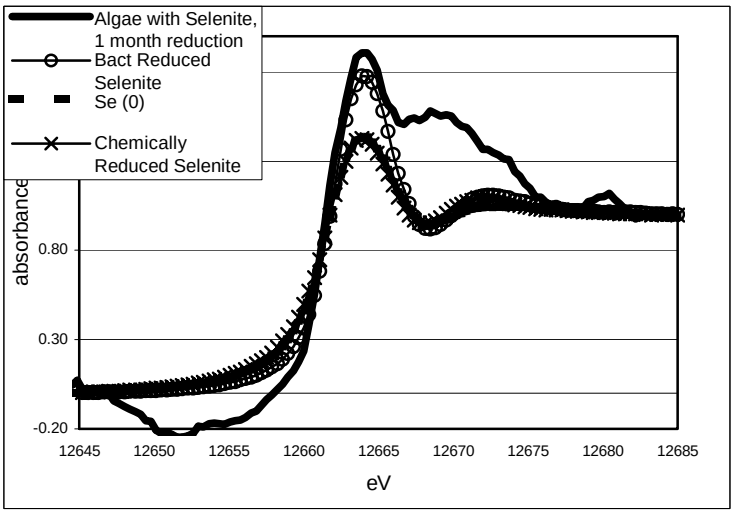

Figure 2: Comparison of the X-ray edge structures of reduced selenium.